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Introduction to Proceedings of SPIE: Optical Engineering at the Lawrence Livermore National Laboratory II

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The second annual conference on optical engineering at Lawrence Livermore National Laboratory (LLNL) focused entirely on National Ignition Facility (NIF) activities. NIF's 192-beam UV laser system is the world's largest optical and optomechanical system. This past year, a decade-long design, construction, fabrication, and installation effort culminated in the commissioning of the first four laser beams in this 30,000 square meter facility. This flashlamp-pumped Nd:glass laser system is built on a scale unprecedented in laser R&D. Nearly every aspect of the NIF design is unconventional, from the 40 x 40-cm-square size of each beam, to the 40 varieties of telephone-booth-size modular optical assemblies, to the elevated configuration of the 200-m-long, class-100 beamlines that converge on a 10-m-diameter target chamber. A large technical staff and many industrial partners were needed to reach the current state of accomplishment, including development of a number of advanced optical materials and fabrication technologies.

NIF follows a succession of glass laser systems built at LLNL over the last 30 years for the purpose of maximizing the power and focusable energy delivered to a target. A primary system design challenge has been to maximize the energy extracted from each laser amplifier while staying below the fluence limit for optical damage. NIF uses a multipass master oscillator power amplifier (MOPA) architecture and is the first LLNL system to include full-aperture, deformable-mirror adaptive optics in each main laser cavity. NIF goes well beyond the simple scale-ups of previous facilities. For example, NIF delivers more than 60 times the energy of the previous large laser system, Nova, at a fraction of the cost per joule and in a facility only 4 times the size of Nova.

On a per-beam basis, the first four beamlines of NIF have already surpassed the primary functional requirements of 1.8 MJ and 500 TW at 351 nm. Single beamline energies of 26 kJ in the IR, 11 kJ in the green, and 10.4 kJ in the UV are the highest achieved anywhere. Beam uniformity, contrast, energy balance, and timing are all exceeding NIF specifications. Target experiments have now begun using NIF as the premier facility for studying inertial confinement fusion and the physics of matter at extreme energy densities and pressures. Initial concepts for deployment of high-energy, picosecond-pulse-width beamlines on NIF have even been developed.

These conference Proceedings are a chronicle of many outstanding optical and mechanical engineering efforts that were required to bring this massive laser system to reality. We hope that providing these presentations as part of Photonics West's LASE 2004 will be useful for a variety of future high-energy and high-power laser systems, and for those interested in solid-state laser system development. The co-chairs would like to express their appreciation to the session chairs, presenters and co-authors, and to the SPIE organizers and staff for making this conference possible.

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